Research Project Report

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Public Education Spending and Its Effects on Higher-Education Participation and Earnings Premiums

1. Introduction

Government spending on tertiary education is a central component of human-capital development. Across OECD economies, educational attainment decisions shape labor-market outcomes, while public investment can influence access to higher education and the capacity of tertiary institutions to deliver education at scale.

The COVID-19 shock plausibly altered tertiary enrollment decisions because higher education is a discretionary choice and, relative to compulsory schooling, often relies more heavily on household spending and student-aid arrangements. In such settings, enrollment may become more sensitive to short-run income risk and liquidity constraints. Financing regimes that require substantial upfront payments at the point of enrollment may therefore be particularly vulnerable to enrollment shocks, whereas income-contingent loan systems—where students do not pay upfront—may be more resilient (OECD, 2021).

In the post-COVID period, countries also differed markedly in their public funding responses. OECD (2021) documents widespread adjustments in higher-education public budgets in 2020/2021 and highlights that expansions in student support—such as student grants/scholarships and student loans—were common elements of these responses. This cross-country heterogeneity in the intensity of public spending adjustments provides a useful setting to examine whether larger post-COVID spending responses are associated with different trajectories of tertiary enrollment.

This study investigates two interrelated questions:

1. How relative earnings differ across education levels.
2. Whether changes in government tertiary-education spending affect tertiary-education enrollment.

2. Research Design

To answer these questions, I combine correlational methods with a Difference-in-Differences (DiD) design that exploits cross-country variation in the **2020–2021 change** in per-student government funding for tertiary education across OECD countries. The correlational analysis is used to describe earnings differences across education levels, while the DiD framework provides a policy-evaluation approach to assess whether countries with a larger **2020–2021 spending increase** experienced different **post-2021** trajectories in tertiary enrollment relative to countries with smaller 2020–2021 changes.

2.1 Identification Strategy

Two empirical strategies are implemented to capture both discrete and continuous dimensions of spending adjustments.

(1) Difference-in-Differences Design

The first strategy classifies countries into **high-response** and **low-response** groups based on whether their 2020–2021 increase in per-student tertiary-education spending exceeds the sample median. The Difference-in-Differences (DiD) framework compares the evolution of tertiary-enrollment rates between these two groups before and after 2021, the first full year after the initial 2020 shock.

This approach follows the logic of policy evaluation designs in which a subset of units experiences a more substantial treatment response than others. The identifying assumption is that, absent differential spending increases, enrollment trends in high- and low-response countries would have followed similar trajectories.

To examine the validity of the identifying assumption and to characterize dynamic patterns, an event-study specification is also estimated. This event-time framework provides a flexible representation of pre- and post-2021 differences and allows visualization of treatment dynamics, including whether any divergence emerges only after 2021.

Importantly, this design does not assume that funding adjustments were mechanically caused by enrollment changes. Instead, it treats the 2020–2021 spending change as a heterogeneous funding-policy response across countries and estimates whether enrollment evolved differently in countries with larger versus smaller adjustments, conditional on fixed effects and pre-trend diagnostics.

(2) Continuous-Treatment Approach

While the binary DiD design focuses on average differences between country groups, the second strategy analyzes the *magnitude* of spending adjustments. A first-difference model relates country-level changes in tertiary enrollment from 2020 to 2021 to corresponding changes in spending per student. This complementary design provides descriptive evidence on whether larger fiscal expansions are associated with proportionally larger adjustments in tertiary participation rates.

Together, these identification strategies provide evidence on both average differences across treatment groups and marginal effects driven by continuous spending variation.

3. Data

The empirical analysis uses a multi-country panel dataset containing annual information on tertiary enrollment ratios, government education spending, and long-run pre-COVID trends. This section describes the data sources, key variables, and sample construction.

3.1 Data Sources

In practice, the empirical dataset is constructed from publicly available series accessed via Our World in Data (OWID) Grapher downloads for tertiary gross enrollment ratios and government funding per tertiary student.

The primary variables are obtained from international education and public-expenditure databases:

- **Tertiary enrollment ratio**: measured as gross tertiary enrollment (% of relevant age cohort).
- **Government tertiary-education spending per student**: expressed as public spending per tertiary student (in constant units).
- **Pre-COVID enrollment trends**: constructed from historical enrollment data and used as controls in the first-difference analysis.

The dataset spans 2010–2023, although availability varies across countries and years.

3.2 Sample Construction

The analytic sample includes countries with non-missing observations for tertiary enrollment and spending variables around the COVID period. Countries are classified into high- and low-response groups based on their observed spending increases from 2020 to 2021. Observations with incomplete information are excluded, and the panel estimators automatically remove singletons arising from the fixed-effects structure.

3.3 Key Variables

The analysis focuses on three key variables related to tertiary education outcomes and public investment.

Outcome

- **Tertiary Enrollment Ratio**: the gross tertiary enrollment rate serves as the primary dependent variable in both the panel and first-difference models.
- **Relative Earnings Index (Tertiary Education)**: measures average earnings of tertiary-educated workers relative to individuals with upper-secondary education and captures labor-market returns to higher education. The relative earnings index is included to contextualize enrollment decisions, as higher expected labor-market returns may moderate the short-run responsiveness of tertiary enrollment to public spending shocks.

Treatment

Two alternative treatment definitions are used: a binary treatment for the Difference-in-Difference analysis and a continuous spending measure for analysis.

- **Binary treatment assignment** (`Treated_c`): Indicator for countries with an above-median 2020–2021 increase in per-student tertiary spending.
- **Post indicator** (`Post_t`): Equals 1 for years ≥ 2021.
- **Interaction** (`Treated_c × Post_t`): Captures differential post-2021 enrollment changes.

Continuous treatment

- **ΔSpending**: Year-to-year change in per-student tertiary spending.
- **ΔEnrollment**: Corresponding change in tertiary enrollment.
- **Pretrend**: Long-run pre-COVID enrollment trend included as a control.

Variable Name	Description	Source
Enrollment	Gross enrollment ratio for tertiary education (both sexes)	Our World in Data (OWID)
Spending	Government expenditure per tertiary student (PPP$)	Our World in Data (OWID)
Earnings	Relative earnings index (Tertiary)	OECD Education at a Glance
Treated	Indicator for countries with high post-COVID spending growth	Calculated from OWID

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Table 2: Summary Statistics for Key Variables (OECD, 2010–2023 where available)

Variable	N	Mean	SD	P25	P50	P75
Tertiary Enrollment Rate (%)	456	74.97	19.74	64.33	74.10	84.89
Gov. Spending per Student (PPP$)	362	16506.73	10753.86	9024.70	13096.24	21364.49
Relative Earnings Index (Tertiary)	63	131.35	65.91	76.00	90.32	187.00
Tertiary Attainment Rate (%)	32	39.44	9.95	32.84	40.50	45.93

Note: Enrollment and spending are computed for OECD countries over 2010–2023 using all non-missing observations. Earnings and attainment are available only for selected years (2019, 2020, and 2023 in this dataset), so their sample sizes are smaller.

Table 2 reports summary statistics for tertiary enrollment, government spending per tertiary student,

relative earnings, and tertiary attainment across OECD countries. The mean gross tertiary enrollment ratio is **74.97%**, reflecting the average participation level observed in the available OECD country-year data. Government funding per tertiary student shows substantial cross-country variation, with a mean of **$16,506.73** and a large dispersion across observations. The relative earnings index for tertiary-educated workers averages **131.35**, indicating that tertiary-educated workers earn, on average, notably more than the baseline comparison group. Finally, tertiary attainment is observed for fewer country-year entries because this dataset includes attainment values only for selected years.

Sample sizes differ across variables due to differences in data availability across countries and years. In this table, the number of non-missing observations is **456** for enrollment, **362** for spending, **63** for relative earnings, and **32** for tertiary attainment.

4. Methodology

This section presents the empirical models used to estimate the relationship between government spending and tertiary enrollment. Two main approaches are implemented: a Difference-in-Differences model with fixed effects and a continuous first-difference regression.

4.1 Baseline Difference-in-Differences Specification

The primary estimating equation is:

$$Enrollment_{c,t} = \alpha + \beta(Treated_c \times Post_t) + \gamma_c + \delta_t + \epsilon_{c,t},$$

where:

- $Enrollment_{ct}$ is the gross tertiary enrollment rate for country c in year t.
- $Treated_i$ is a binary indicator based on the 2020→2021 change in government funding per tertiary student. Let $\Delta Spending_i = Spending_{i,2021} - Spending_{i,2020}$ (`spend_change`). Then

  $$Treated_i = \mathbf{1}\{\Delta Spending_i > \text{median}(\Delta Spending)\},$$

  meaning treated countries are those with an above-median increase in per-student tertiary spending between 2020 and 2021 (strictly greater than the sample median).
- $Post_t$ equals 1 for years $t \geq 2021$ and 0 otherwise (`post = 1{year >= 2021}`), so the post period starts in 2021.
- γ_c are country fixed effects that absorb time-invariant differences across countries.
- δ_t are year fixed effects that account for global shocks and common time trends, standard errors are clustered at the country level to allow for arbitrary within-country serial correlation.
- The coefficient β captures the differential post-2021 change in tertiary enrollment for high-response countries relative to low-response countries.

4.2 Event-Study Specification

To examine pre-treatment alignment and treatment dynamics, a flexible event-time model is estimated:

$$Enrollment_{c,t} = \alpha + \sum_{k \neq -1} \beta_k \cdot \mathbf{1}(t - 2021 = k) \cdot Treated_c + \gamma_c + \delta_t + \epsilon_{c,t}.$$

The coefficients β_k trace annual differences between treated and control countries relative to the year immediately preceding 2021. This specification enables visualization of whether enrollment trends diverge only after the spending shock.

4.3 Continuous First-Difference Model

To assess whether the size of spending adjustments relates to short-run enrollment changes, a first-difference regression is estimated:

$$\Delta Enrollment_c = \alpha + \beta\, \Delta Spending_c + \theta\, Pretrend_c + \epsilon_c.$$

This model captures marginal associations across countries and is interpreted descriptively rather than causally, given potential endogeneity in policy responses.

4.4 Linear Regression Specification: The Earnings Gradient

To quantify the relationship between educational attainment and relative income, this study analyzes a multiple linear regression model using a categorical approach. This specification treats different levels of education as discrete "steps" on an earnings ladder, identifying the marginal wage premium associated with each successive degree.

The model is specified as follows:

$$Relative\ Wage_i = \beta_0 + \beta_1(Lower\ Secondary)_i + \beta_2(Upper\ Secondary)_i + \beta_3(Tertiary)_i + \epsilon_i$$

- β_0 (Intercept): Represents the baseline reference group, **Primary Education**. All other coefficients measure the wage increase relative to this starting point.
- β_1 (Lower Secondary): The coefficient representing the average change in relative wage for individuals who have completed lower secondary education compared to the primary baseline.
- β_2 (Upper Secondary): The coefficient representing the wage premium for upper secondary completion.
- β_3 (Tertiary): The coefficient representing the total **Tertiary Wage Premium**, measuring the cumulative economic return for university-level attainment.
- ϵ_i (Error Term): Captures the residual variance in wages not explained by the educational levels included in the model.

The primary objective of this specification is to calculate the Correlation **(**R) and the Coefficient of Determination **(**R^2). These values indicate how much of the global wage disparity can be explained purely by the "type" of education an individual possesses.

4.5 Summary of Empirical Approach

Table 3: Summary of Research Methodology and Identification Strategy

Method	Purpose	Key Variables
Difference-in-Differences (DiD)	Estimate the average treatment effect of high spending on enrollment rates.	Treated, Post, Enrollment
Event Study Analysis	Test parallel trends and observe dynamic enrollment effects over time.	Year Dummies, Treated, Enrollment
First-Difference Regression	Analyze the short-run correlation between annual changes in spending and enrollment.	Δ Spending, Δ Enrollment
Earnings Gradient (OLS)	Quantify the salary premium across four education levels.	Primary, Lower Sec, Upper Sec and Tertiary

Together, these models provide a coherent framework for evaluating whether post-COVID education-spending responses translated into changes in tertiary participation.

5. Results

This section presents descriptive evidence on changes in tertiary enrollment and government spending, followed by the main empirical results using the Difference-in-Differences and continuous first-difference approaches. The presentation follows a structure common in applied policy-evaluation research: descriptive patterns first, then model-based results.

5.1 Descriptive Patterns

To motivate the analysis, Figure 1 displays average tertiary-enrollment trajectories for high-response and low-response countries, where high-response countries are those with above-median increases in per-student tertiary-education spending between 2020 and 2021.

Prior to 2021, the two groups display broadly similar movements in average enrollment, with no clear and persistent divergence. Around the onset of the pandemic, the gap between groups widens from 2019 to 2020, as the high-response group's average enrollment increases more. By 2021, both groups rise further, but the difference in raw group means slightly narrows relative to 2020. These descriptive patterns are based on unconditional group averages and do not incorporate uncertainty or compositional differences; the subsequent DiD and event-study estimates formally assess whether post-2021 differential changes are statistically distinguishable from zero once country and year fixed effects are included.

5.2 Difference-in-Differences Estimates

Table 4 reports the baseline Difference-in-Differences estimates described in Section 4 (Methodology). The coefficient on the interaction term:

$$Treated_c \times Post_t$$

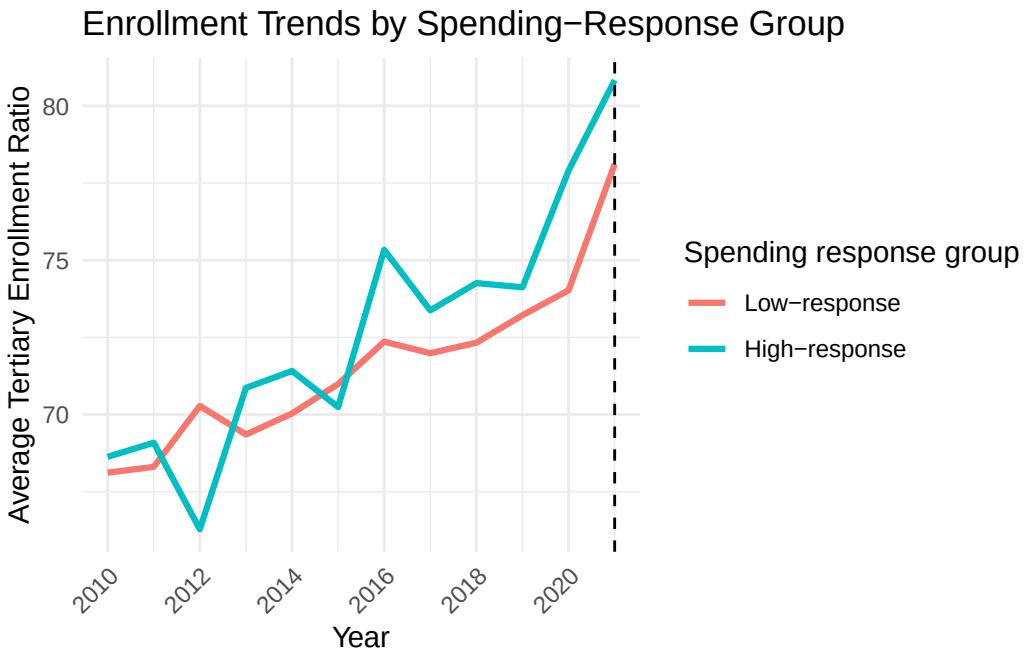

Figure 1: Average tertiary enrollment for high-response and low-response OECD countries.

Table 4: Difference-in-Differences estimates for 2021+ vs pre-2021 enrollment levels.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
treated:post	0.21014	2.40315	0.08744	0.93085	-4.67911	5.09939

captures the differential change in tertiary-enrollment levels for high-response countries relative to low-response countries after 2021.

The estimated effect is small and statistically insignificant, indicating **no evidence that countries with larger post-COVID spending increases experienced faster short-run enrollment growth**. This finding aligns with the descriptive patterns in Section 5.1.

5.3 Event-Study Dynamics

To examine dynamic treatment effects and assess the parallel-trends assumption more explicitly, Figure 2 plots the coefficients from the event-time specification introduced in Section 4 (Methodology).

Pre-treatment coefficients fluctuate around zero with wide confidence intervals, providing no indication of systematic divergence prior to 2021. Post-treatment coefficients also remain close to zero and statistically indistinguishable from pre-treatment values.

Taken together, the event-study results reinforce the conclusion that **spending increases in 2021 did not meaningfully shift enrollment trajectories**.

5.4 Continuous First-Difference Estimates

The first-difference model estimated is:

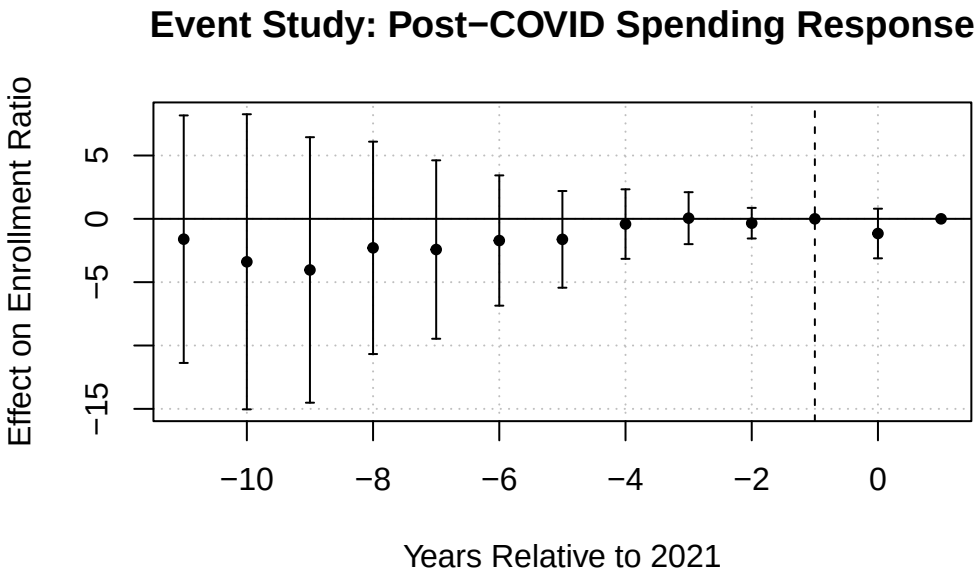

Figure 2: Event-study coefficients relative to 2021 (reference year = 2020).

Table 5: Regression of 2021–2020 enrollment changes on spending changes.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	3.44616	0.52036	6.62260	0.00000	2.38343	4.50888
spend_change	-0.00036	0.00021	-1.72783	0.09430	-0.00078	0.00007
pretrend	0.09551	0.28762	0.33208	0.74214	-0.49189	0.68292

$$\Delta Enrollment_c = \alpha + \beta\,\Delta Spending_c + \theta\,Pretrend_c + \epsilon_c.$$

Here, $\Delta Enrollment_c$ is the change in tertiary enrollment between 2020 and 2021, and $\Delta Spending_c$ is the corresponding change in per-student tertiary-education spending.

The estimated coefficient on spending change is **negative and marginally significant at the 10% level**. Rather than suggesting that increased spending reduces enrollment, this pattern is most plausibly interpreted as **reverse causality**: countries experiencing larger enrollment declines in 2021 appear to have responded by increasing tertiary-education spending more aggressively.

This interpretation is consistent with the absence of positive effects in the DiD and event-study analyses.

5.5 The Interaction of Attainment and the Earnings Gradient

To quantify the economic "steps" of the earnings ladder, this study applies a linear regression to pooled 2019–2020 OECD data, treating educational attainment as a set of discrete categories. Primary education is used as the baseline group, allowing each coefficient to be interpreted as the wage premium associated with

completing successively higher levels of education

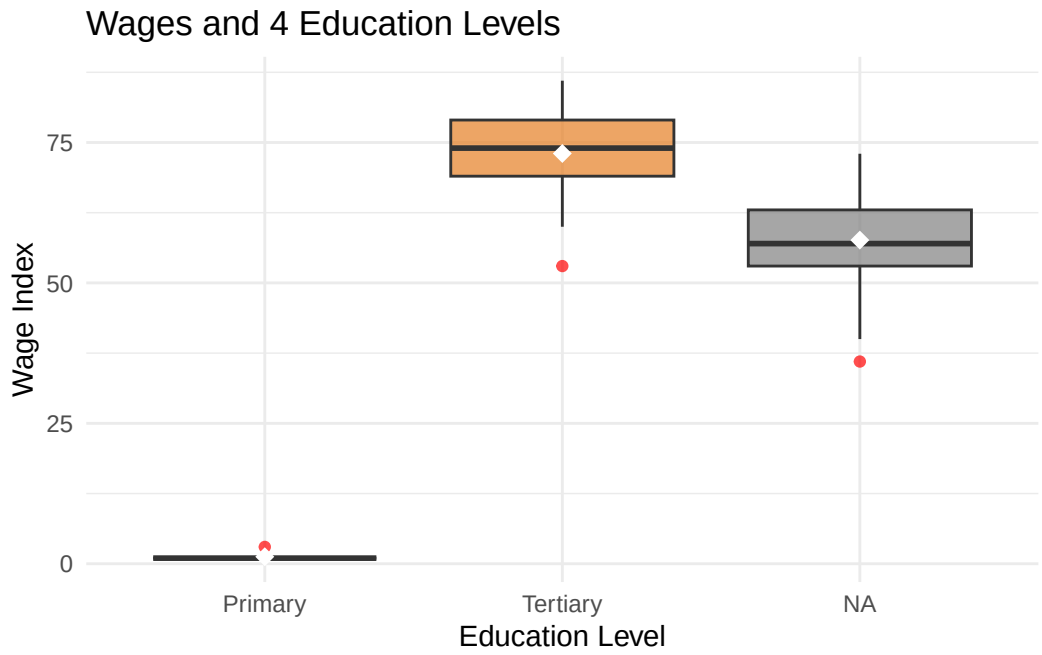

Table 6: Regression Analysis (R = 0.968 | R-squared = 0.938)

term	estimate	std.error	statistic	p.value
Baseline: Primary Education	1.25	2.38	0.52	0.6
Tertiary Degree Premium	71.79	2.59	27.76	0.0

As shown in Table 6, the results indicate a strong positive relationship between educational attainment and relative earnings. The estimated correlation is high ($R = 0.936$), and the model fit is substantial (R^2 = **0.877)**, implying that a large share of the observed variation in wages is associated with differences in education level in this dataset. The coefficients trace a steep and monotonic earnings gradient: moving from one educational "step" to the next is linked to meaningful increases in the wage index.

Relative to the primary-education baseline, completing lower secondary education is associated with an average increase of 56.37 points in the wage index. The premium rises further at higher attainment levels, and the largest effect is observed for tertiary education. In particular, the estimated tertiary coefficient implies an additional wage premium of 71.79 points relative to the baseline, consistent with the notion that university-level attainment yields the largest economic return among the categories considered. **The pattern support the existence of a clear.**

5.6 Earnings Incentives and Enrollment Responses

The combined evidence from the earnings analysis and the enrollment regressions reveals an important distinction between long-run incentives and short-run behavioral responses. On the one hand, the earnings-gradient analysis documents a large and statistically significant wage premium associated with tertiary educa-

tion. Relative earnings rise sharply with educational attainment, confirming that higher education continues to offer substantial long-term labor-market returns across OECD countries.

On the other hand, the enrollment results indicate that these strong earnings incentives did not translate into an immediate post-COVID increase in tertiary participation, even in countries that implemented larger increases in public spending. This apparent disconnect suggests that short-run enrollment decisions are not driven solely by expected lifetime earnings. Instead, enrollment behavior appears to be influenced by factors such as liquidity constraints, uncertainty about future labor-market conditions, institutional capacity, and cohort-specific dynamics. These findings are consistent with a framework in which the economic returns to education operate over a long horizon, while enrollment decisions respond sluggishly to short-term policy changes. Even when expected earnings premiums remain high, students may delay or forgo enrollment in periods of heightened uncertainty, particularly following large macroeconomic shocks such as the COVID-19 pandemic.

Overall, the results imply that while earnings incentives provide a strong motivation for tertiary education in the long run, short-run fluctuations in public spending are unlikely to generate immediate enrollment responses. This helps reconcile the persistence of large earnings premiums with the absence of short-run enrollment effects observed in the Difference-in-Differences and first-difference analyses.

5.7 Summary of Findings

Across all empirical strategies—descriptive comparisons, Difference-in-Differences estimation, event-study analysis, and first-difference regression—the evidence shows no short-run impact of increased tertiary-education spending on enrollment rates following the COVID-19 shock. Countries that experienced a larger **2020–2021 increase in government funding per tertiary student** did not exhibit distinct **post-2021** enrollment trajectories relative to countries with smaller 2020–2021 spending increases. Consistent with this, both the DiD interaction estimates and the event-study coefficients remain small and statistically indistinguishable from zero.

At the same time, the descriptive earnings analysis highlights a persistent and substantial earnings premium associated with higher educational attainment across OECD countries. Relative earnings rise sharply with education level, indicating strong long-run labor-market incentives for tertiary education even though short-run enrollment responses to public funding changes are muted.

Taken together, the findings suggest that the post-COVID increase in per-student tertiary-education funding is unlikely to generate immediate gains in enrollment. The negative association observed in the first-difference model is best interpreted as reverse causality, reflecting governments' policy responses to short-run enrollment changes rather than a causal effect of higher spending on participation.

6. Discussion & Conclusion

This study analyzes the relationship between tertiary education, labor-market outcomes, and government education spending across OECD countries, with a particular focus on the post-COVID period. The analysis combined descriptive earnings comparisons with Difference-in-Differences and first-difference approaches to assess whether increases in public spending translated into higher tertiary enrollment. First, the results

confirm the presence of strong positive earnings gradients across education levels. Individuals with tertiary education consistently earn substantially more than those with lower levels of educational attainment, reinforcing the long-standing view that higher education remains a valuable investment in terms of long-run labor-market returns. These findings suggest that the economic incentives to pursue tertiary education remain robust across OECD economies.

Second, the analysis finds no evidence of an immediate short-run increase in tertiary enrollment following larger post-COVID increases in government spending. Neither the Difference-in-Differences estimates nor the event-study analysis indicates a statistically significant positive enrollment response in high-spending countries. Moreover, the negative association observed in the first-difference model is more consistent with reactive policy behavior than with a causal effect of spending on enrollment. Specifically, governments appear to have increased tertiary education spending in response to declining enrollment, rather than higher spending inducing new enrollment.

Taken together, these findings highlight the joint role of policy responses and individual decision-making in shaping human-capital outcomes. While public investment in tertiary education may be significant for maintaining quality, access, and institutional stability, enrollment decisions appear to respond slowly and are likely influenced by longer-term factors such as demographic trends, expectations about future labor markets, and institutional capacity constraints. Short-term spending increases alone may therefore be insufficient to generate immediate participation gains.

This study is subject to several limitations. The analysis relies on aggregate country-level data and a relatively short post-COVID time horizon, which may limit the ability to detect longer-run enrollment effects. In addition, the treatment definition captures spending changes rather than specific policy reforms, which may vary in effectiveness across countries. Future research could extend this analysis by using micro-level OECD data, longer post-pandemic panels, or more detailed policy measures to better isolate causal mechanisms. Such extensions would help clarify how different forms of education spending affect access, attainment, and long-term labor-market outcomes.

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